Acronym: Cambium

Title: Cambium

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Developer(s): Kennedy Space Center, FL
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Sponsoring Agency: Canadian Space Agency (CSA)

Increment(s) Assigned: 19, 20

Brief Research Summary (PAO): The Cambium investigation is one in a pair of investigations which utilizes the Advanced Biological Research System (ABRS). Cambium seeks definitive evidence that gravity has a direct effect on cambial cells (cells located under the inner bark where secondary growth occurs) in willow, *Salix babylonica*.

Research Summary:

- The Cambium investigation uses willow plants flown on the International Space Station to better understand the fundamental processes by which plants produce cellulose and lignin, the two main structural materials found in plant matter.

- On Earth, the nature of wood within tree stems varies depending on position, and that within-tree variation includes differences in cell types and chemistry including lignin and cellulose, two major components of wood influencing wood strength, usefulness and carbon content. Reaction wood is an extreme example of such variation, and it is believed that reaction wood develops as a reaction to the influence of gravity.

- For the Cambium experiment, young willow plants will be launched to the ISS where their stems will be looped in an attempt to induce reaction wood formation. After on-orbit growth, the plants will be preserved and returned to Earth for analysis.

- Understanding the role of gravity in wood formation is expected to enable wiser management of forests for carbon sequestration as well as better utilization of trees for wood products.

Detailed Research Description: The Cambium experiment will provide an understanding of physiological processes such as gene expression, metabolism and general plant development that are affected in plant systems exposed to space flight. Cambium seeks definitive evidence that gravity has a direct effect on the cambial cells (cells located under the inner bark where secondary growth occurs) that

contribute to xylogenesis (reaction wood formation) in willow plants, *Salix babylonica*. Tension wood fibers differentiate on the upper sides of stems when the stem is altered from its normal (vertical) growth position by looping. This reaction wood response does not occur if the orientation of the plant stem with respect to gravity is not altered. If a localized zone of tension wood should be formed in looped stems under microgravity conditions, this would be the first conclusive evidence that gravity is not required. On the other hand, if a zone of tension wood is not produced in looped stems (subjected to tension on one side, compression on the other) in microgravity, this would be the first definitive evidence that gravity has a direct effect on the cambial cells which contribute to reaction wood formation. Following return to Earth the plants will be analyzed by microscopy and chemical methods.

Project Type: Payload

Image and Captions:

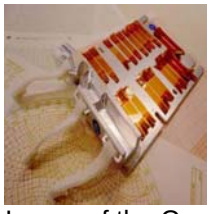
Image of the Cambium looping tool prototype. Image provided by the Canadian Space Agency.


Looped willow plant and photogrid. Image provided by The Bionetics Corporation, Kennedy Space Center, FL .

Operations Location: ISS Inflight

Brief Research Operations:

- Cambium willow plants, *Salix babylonica*, are launched live along with the powered Advanced Biological Research System (ABRS).
- Once transferred to ISS, plant looping is conducted for the first session 5 to 8 days after launch. Plant growth continues for 30 days post looping prior to harvesting for return to Earth.
- Additional sessions follow the same procedure.

Operational Requirements: Cambium requires a controlled environment provided by the ABRS facility which also provides images that are downlinked to the ground teams. The crew is responsible for stem looping, harvesting, reinitialization, water refill, and changing out the air filter. After harvesting, parts of the samples are chemically preserved and stored in the Minus Eighty-Degree Laboratory Freezer for ISS (MELFI).

Operational Protocols: The crew is responsible for performing the stem looping of the plants by using a looping tool that fashions a loop of reproducible size followed by application of a restraining tape to maintain the looped configuration. After the growth period the plants are harvested by cutting the looped stem and analogous unlooped stems from control plants. These stem portions are then placed into KSC

fixation tubes (KFTs) containing chemical preservatives and stored at ambient conditions or frozen in MELFI.

To maintain the environment in the ABRS the crew uses a syringe to transfer approximately 60-mL of water from the ISS potable water source to each of two quick disconnect fittings associated with the two reservoirs inside the ABRS. Air filter change out is performed by opening the front hatch of the ABRS locker, loosening a Velcro restraining strap, and pulling each of the two filters off of the back side of the hatch. There are blind mate connectors on the back side of each filter.

Review Cycle Status: PI Reviewed

Category: Biological Sciences in Microgravity

Sub-Category: Plant Biology

Space Applications: Cambium along with the ABRS hardware demonstrates the capabilities of providing the correct environment for plant growth onboard spacecraft. For future long-duration exploration, crews will need to be able to grow plants for a variety of applications.

Earth Applications: Understanding the fundamental processes by which plant cells differentiate to produce wood enriched in cellulose and lignin is of great interest in the realm of forestry and industry. For paper production, pulp and paper industries desire that wood contains elevated cellulose and reduced lignin content such as occurs in tension wood, and wood used to make structural lumber and other wood products is selected for uniformity in anatomical as well as chemical composition. In addition to these practical applications, within-organism control of cellular differentiation remains the greatest mystery of the biological sciences, and understanding the role of gravity in the regulation of gene expression and biochemistry underlying formation of different kinds of wood will contribute to the overall quest.

Manifest Status: Continuing

Supporting Organization: Canadian Space Agency (CSA)

Previous Missions: The Cambium experiment has no previous flight history.

Related Payload(s): TAGES

Last Update: 02/12/2009